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(54) **SWITCHING MODE POWER SUPPLY AND THE METHOD THEREOF**

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G05F 1/44 (2006.01)

(52) **U.S. Cl.**
USPC **323/282**

(58) **Field of Classification Search**
USPC 323/222, 224, 225, 282, 283, 285, 351
See application file for complete search history.

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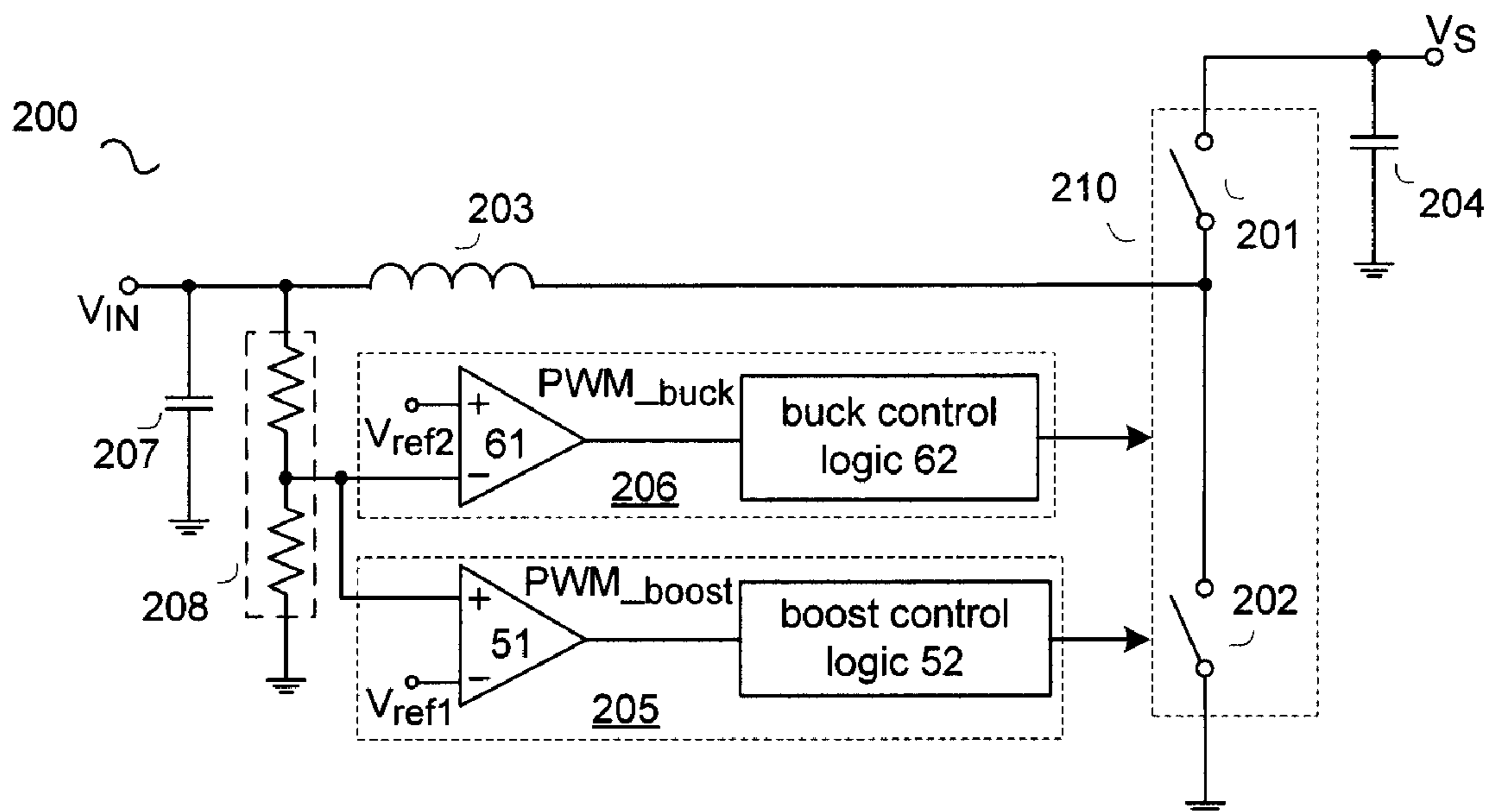
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(57) **ABSTRACT**

The present disclosure discloses a switching mode power supply with bi-direction buck and boost control. The switching mode power supply enters boost mode when an input signal is higher than a preset threshold to pump the input signal to a higher level; and the switching mode power supply enters buck mode when the input signal breaks down to release the stored energy.

20 Claims, 3 Drawing Sheets



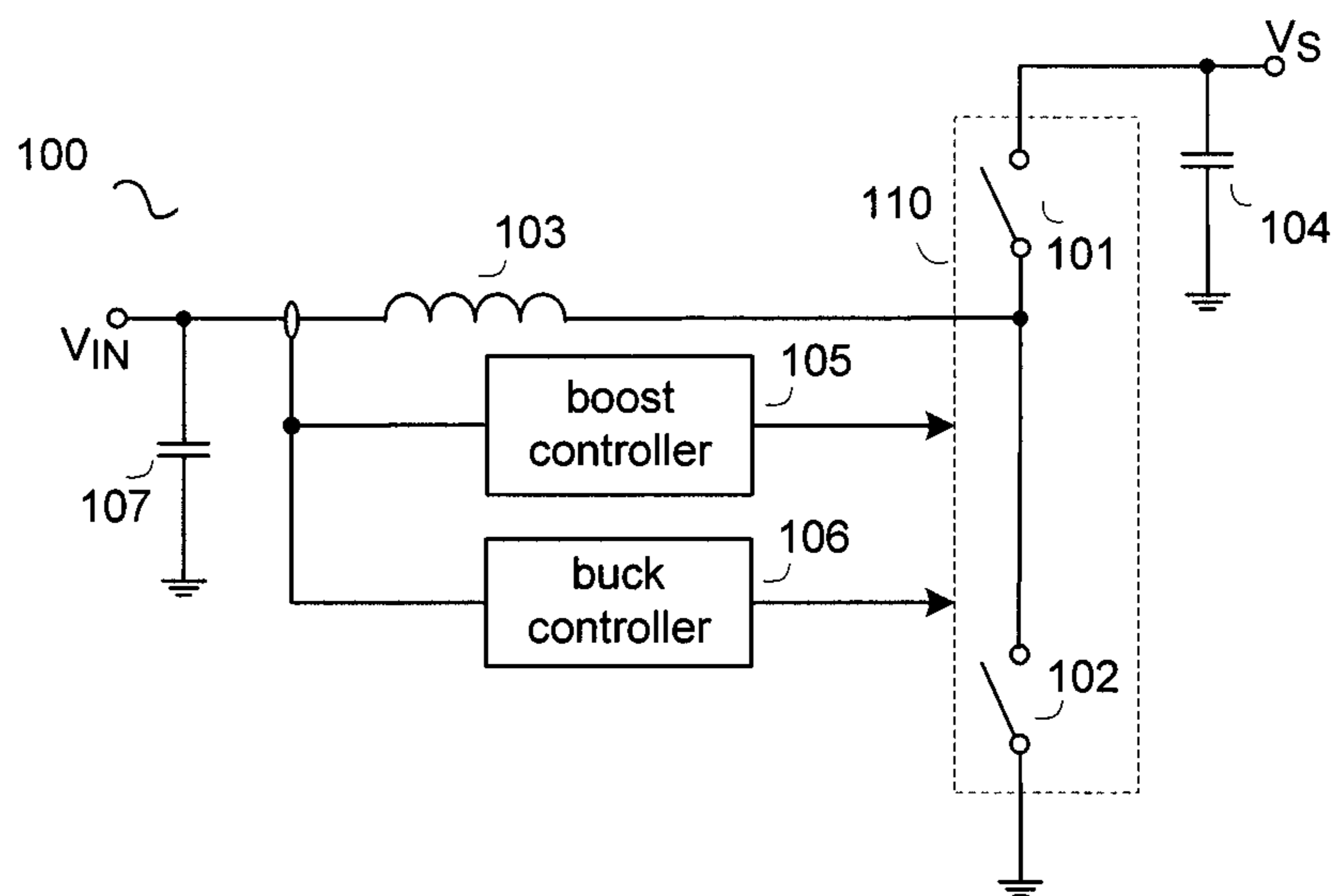


FIG. 1

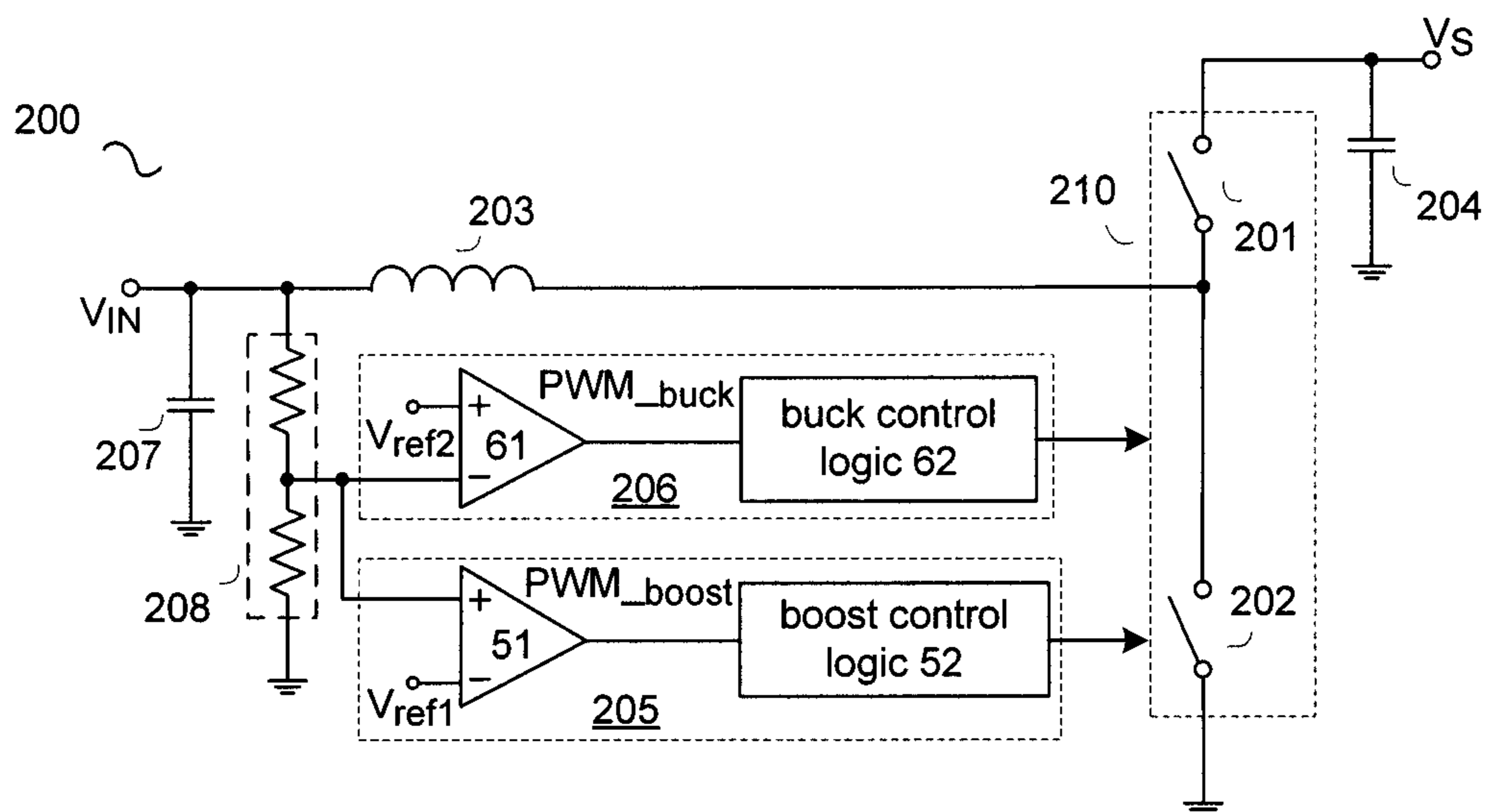


FIG. 2

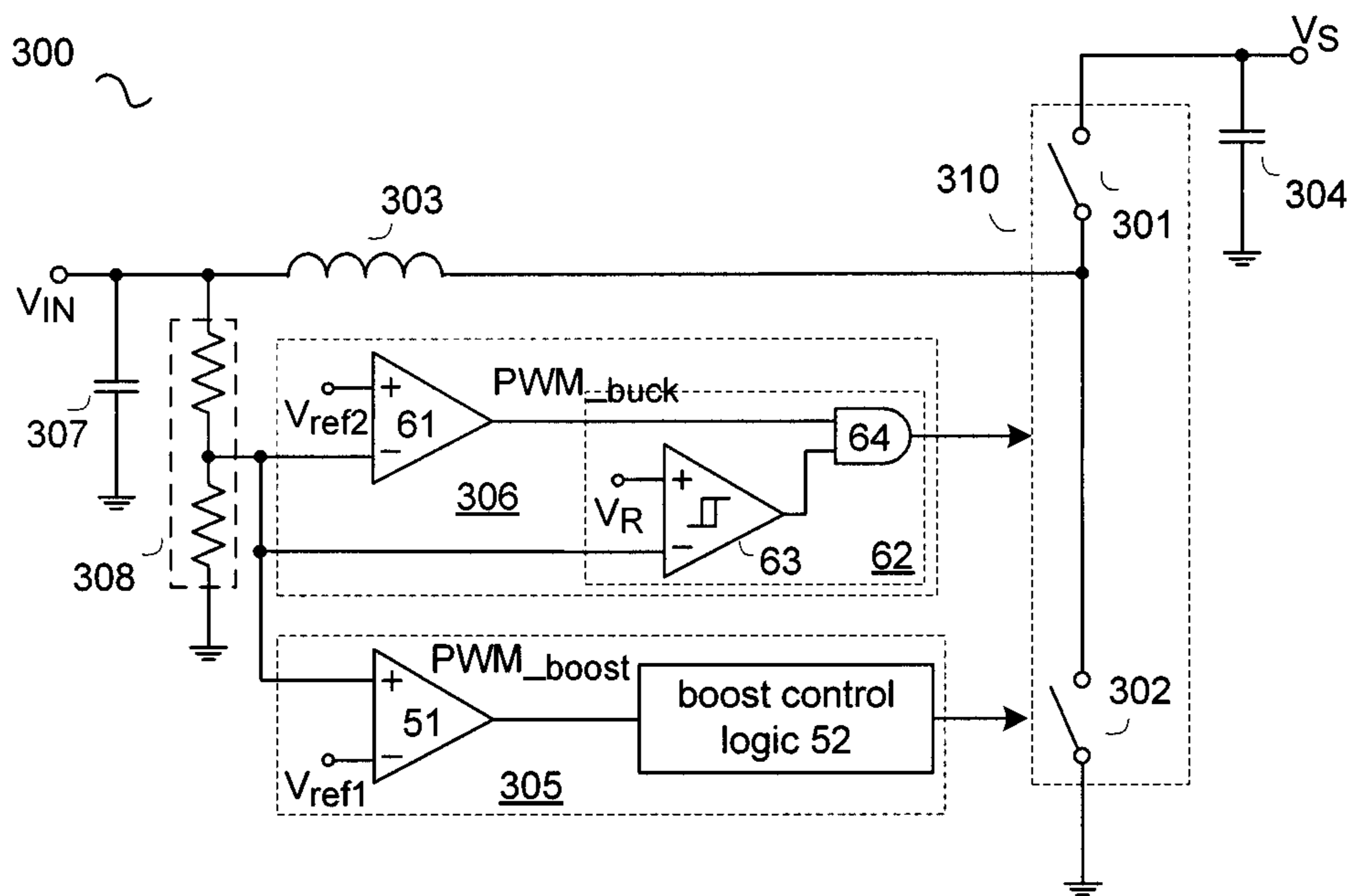


FIG. 3

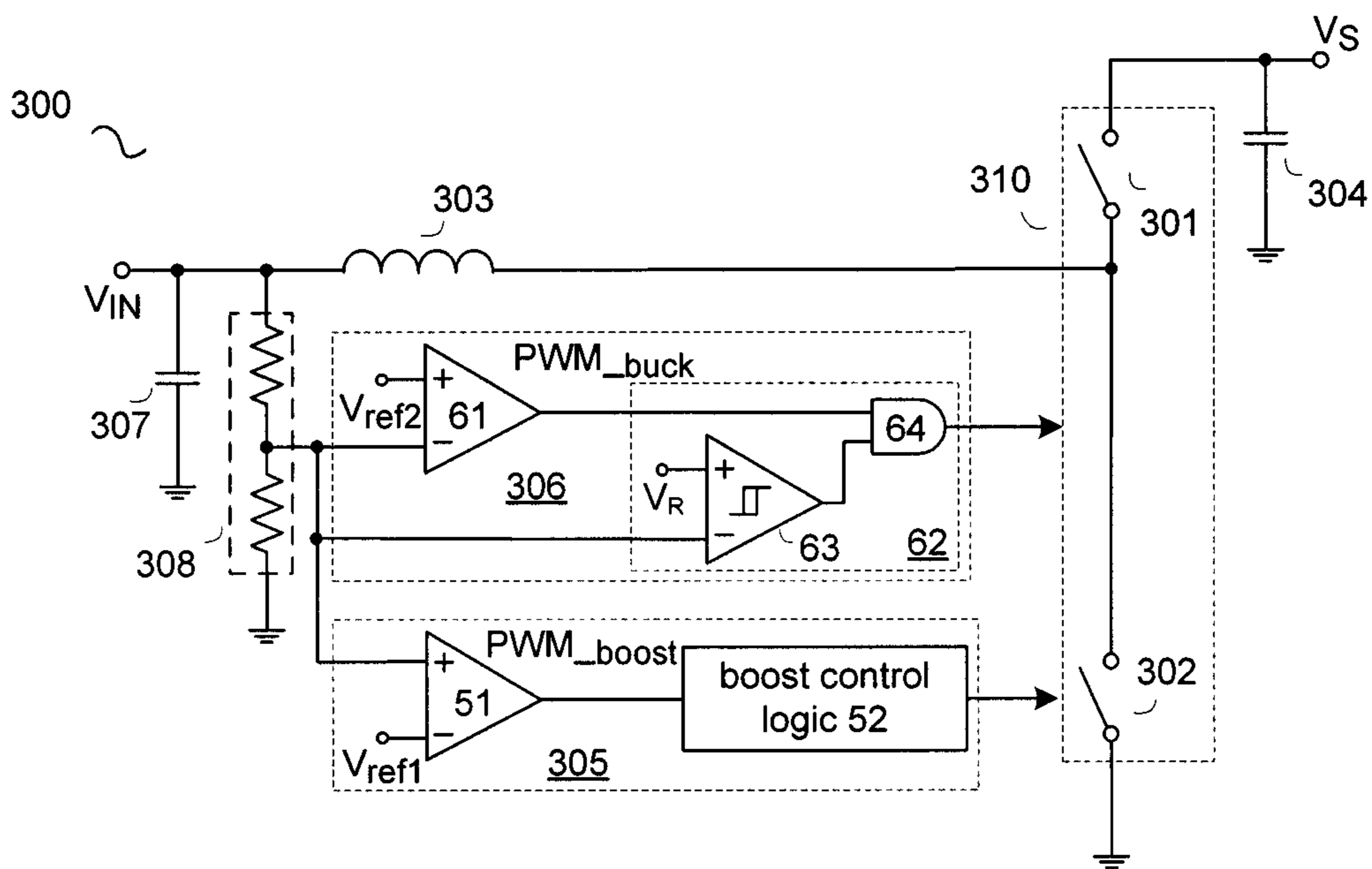


FIG. 4

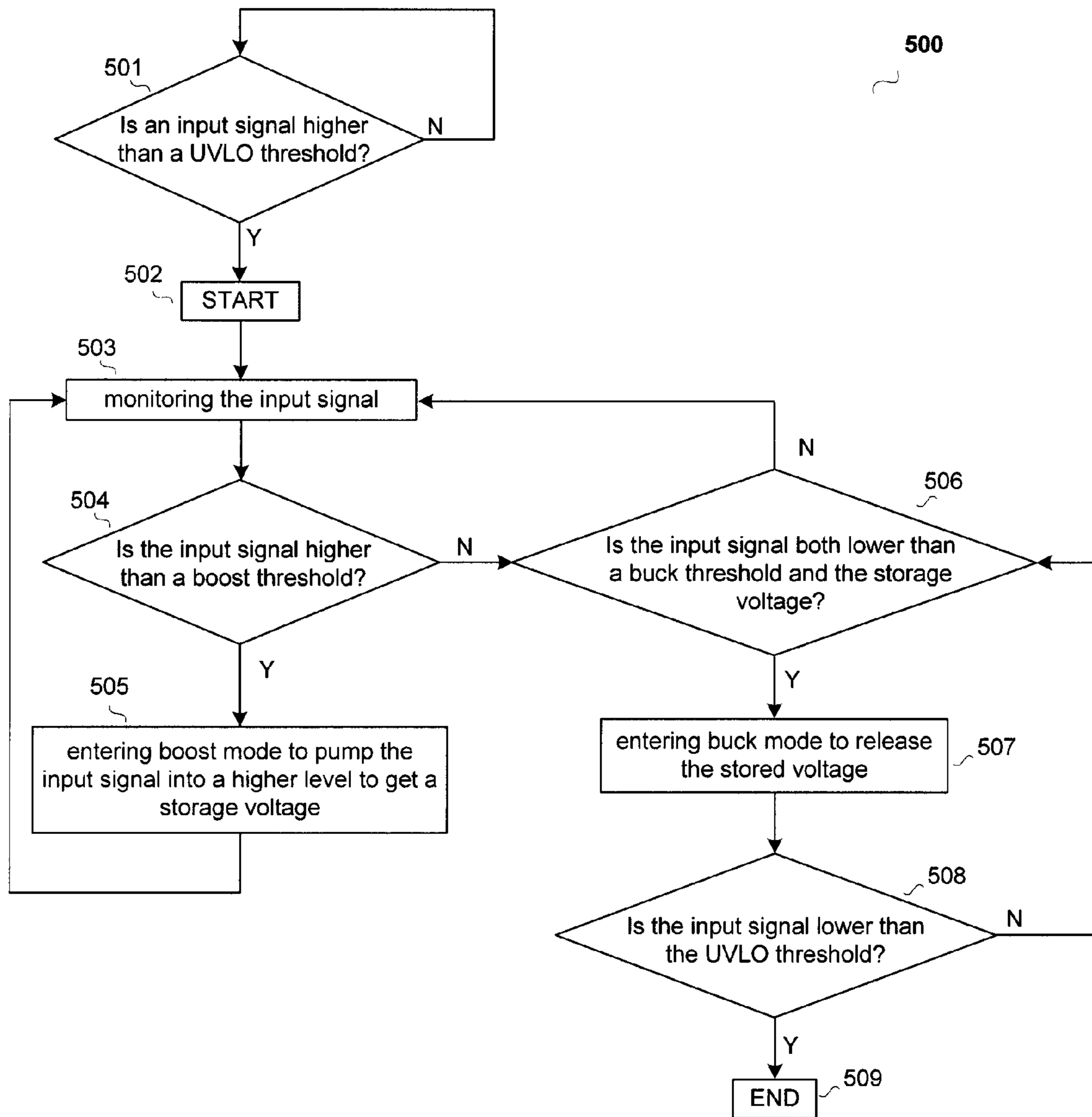


FIG. 5

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SWITCHING MODE POWER SUPPLY AND THE METHOD THEREOF

TECHNICAL FIELD

The present disclosure relates generally to electrical circuits, and more particularly but not exclusively to switching mode power supplies.

BACKGROUND

In typical DSL or ADSL applications, extended to the solid state drive or hard disk drive application, a plurality of storage capacitors coupled in parallel are commonly used to store energy to support sudden power shutdown, which highly increases the system cost.

Storing the energy in a high voltage form and releasing the energy when the power fails can reduce the amount of storage capacitors. Prior art using the combination of a charge pump and a LDO (low dropout) circuit to achieve the energy management, where the charge pump is used to pump the input signal to a higher voltage and the LDO circuit is used to release the stored energy. However, the charge pump needs many switches, which make the system complicated. But to achieve higher storage voltage, more switches are needed. In addition, the LDO circuit has large power loss during the releasing which dramatically reduces the system efficiency and increases again the system burden.

SUMMARY

It is an object of the present disclosure to provide a switching mode power supply that resolves the above problems.

In accomplishing the above and other objects, there has been provided, in accordance with an embodiment of the present disclosure, a switching mode power supply, comprising: an input port configured to receive an input signal; a storage port configured to provide a storage voltage; an inductor having a first terminal and a second terminal, wherein the first terminal is coupled to the input port to receive the input signal; a power stage coupled between the second terminal of the inductor and the storage port; a storage capacitor coupled between the storage port and ground to store energy; a boost controller configured to receive a feed forward signal indicative of the input signal, and generates a boost control signal to control the power stage to operate in boost mode when the input signal is higher than a boost threshold; and a buck controller configured to receive the feed forward signal indicative of the input signal, and generates a buck control signal to control the power stage to operate in buck mode, when the input signal is lower than a buck threshold and when the storage voltage is higher than the input signal; wherein the buck threshold is lower than the boost threshold.

In addition, there has been provided, in accordance with an embodiment of the present disclosure, a method used for a switching mode power supply, comprising: comparing an input signal with a UVLO threshold: start to operate the switching mode power supply until the input signal is higher than the UVLO threshold; comparing the input signal with a boost threshold: if the input signal is higher than the boost threshold, controlling the switching mode power supply enter boost mode to pump the input signal into a higher level to get a storage voltage; and if not, go to next step; comparing the input signal with a buck threshold and the storage voltage: if the input signal is lower than both the buck threshold and the storage voltage, controlling the switching mode power supply enter buck mode to release the stored voltage; and if not, go to

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next step; and comparing the input signal again with the UVLO threshold: if the input signal is lower than the UVLO threshold, stopping the operation of the switching mode power supply; and if not, back to the step of comparing the input signal with the buck threshold and the storage voltage.

Furthermore, there has been provided, in accordance with an embodiment of the present disclosure, a switching mode power supply, comprising: an input port configured to receive an input signal; a storage port configured to provide a storage voltage; an inductor having a first terminal and a second terminal, wherein the first terminal is coupled to the input port to receive the input signal; an upper switch having a first terminal and a second terminal, wherein the first terminal is coupled to the second terminal of the inductor, the second terminal is coupled to the storage port; a lower switch having a first terminal and a second terminal, wherein the first terminal is coupled to the second terminal of the inductor, the second terminal is coupled to a reference ground; a storage capacitor coupled between the storage port and ground to store energy; a boost controller configured to receive a feed forward signal indicative of the input signal, and generates a boost control signal to control the upper switch and the lower switch to cause the switching mode power supply operate in boost mode when the input signal is higher than a boost threshold; and a buck controller configured to receive the feed forward signal indicative of the input signal, and generates a buck control signal to control the upper switch and the lower switch to cause the switching mode power supply operate in buck mode, when the input signal is lower than a buck threshold and when the storage voltage is higher than the input signal; wherein the buck threshold is lower than the boost threshold.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 schematically shows a switching mode power supply **100** in accordance with an embodiment of the present disclosure.

FIG. 2 schematically shows a switching mode power supply **200** with a buck controller **205** and a boost controller **206** in accordance with an embodiment of the present disclosure.

FIG. 3 schematically shows a switching mode power supply **300** with a buck controller **305** in accordance with an embodiment of the present disclosure.

FIG. 4 schematically shows a switching mode power supply **400** with a buck controller **405** in accordance with an embodiment of the present disclosure.

FIG. 5 schematic shows a flowchart **500** of a method for a switching mode power supply in accordance with an embodiment of the present disclosure.

The use of the same reference label in different drawings indicates the same or like components.

DETAILED DESCRIPTION

In the present disclosure, numerous specific details are provided, such as examples of circuits, components, and methods, to provide a thorough understanding of embodiments of the disclosure. Persons of ordinary skill in the art will recognize, however, that the disclosure can be practiced without one or more of the specific details. In other instances, well-known details are not shown or described to avoid obscuring aspects of the disclosure.

FIG. 1 schematically shows a switching mode power supply **100** in accordance with an embodiment of the present disclosure. In the example of FIG. 1, the switching mode power supply **100** comprises: an input port configured to

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receive an input signal V_{IN} ; a storage port configured to provide a storage voltage V_S ; an inductor **103** having a first terminal and a second terminal, wherein the first terminal is coupled to the input port to receive the input signal V_{IN} ; a power stage **110** coupled between the second terminal of the inductor **103** and the storage port; a storage capacitor **104** coupled between the storage port and ground to store energy; a boost controller **105** configured to receive a feed forward signal indicative of the input signal V_{IN} , and generates a boost control signal to control the power stage **110** to operate in boost mode when the input signal is higher than a boost threshold; and a buck controller **106** configured to receive the feed forward signal indicative of the input signal V_{IN} , and generates a buck control signal to control the power stage **110** to operate in buck mode when the input signal is lower than a buck threshold and when the storage voltage V_S is higher than the input signal V_{IN} ; wherein the buck threshold is lower than the boost threshold.

In one embodiment, the switching mode power supply **100** further comprises a UVLO (under voltage lock out) block (not shown) configured to compare the input signal with a UVLO reference. If the input signal is higher than the UVLO threshold, the switching mode power **100** starts to operate; and if the input signal is lower than the UVLO threshold, the operation of the switching mode power supply **100** ends.

In one embodiment, the switching mode power supply **100** further comprises an input capacitor **107** coupled between the input port and a reference ground to smooth the input signal V_{IN} .

In one embodiment, the power stage **110** comprises an upper switch **101** and a lower switch **102** coupled in series between the storage port and the reference ground, and the conjunction of the upper switch **101** and the lower switch **102** is coupled to the second terminal of the inductor **103**.

In one embodiment, the upper switch **101** and the lower switch **102** comprise a MOSFET, respectively. One skilled in relevant art will recognize, however, the upper switch **101** and the lower switch **102** may comprise other kinds of semiconductor devices, such as IGBT, BJT, etc. . . .

When the input signal V_{IN} is higher the UVLO threshold, the switching mode power supply **100** is in operation. If the voltage level of the input signal is higher than the boost threshold, the buck controller **106** is blocked, and the boost controller **105** is activated to provide the boost control signal to the power stage **110** to control the power stage to operate in boost mode, so that the input signal is pumped to a desired high voltage at the storage port. If the voltage level of the input signal is lower than the buck threshold and the storage voltage V_S is higher than the input signal V_{IN} , the boost controller **105** is blocked, and the buck controller **106** is activated to provide the buck control signal to the power stage **110** to control the power stage to operate in buck mode, so that the energy stored at the storage capacitor **104** is released via the power stage **110** and the inductor **103**. If the voltage level of the input signal is lower than the boost threshold and higher than the buck threshold, the power stage **110** operates as its previous state.

FIG. 2 schematically shows a switching mode power supply **200** with a boost controller **205** and a buck controller **206** in accordance with an embodiment of the present disclosure. In the example of FIG. 2, the boost controller **205** comprises: a first comparator **51** having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal V_{IN} , the second input terminal is configured to receive a first threshold V_{ref1} , and wherein based on the feed forward signal and the first threshold V_{ref1} ,

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the first comparator **51** generates the boost status signal PWM_{boost} at the output terminal; and a boost control logic unit **52** coupled to the output terminal of the first comparator **51** to receive the boost status signal PWM_{boost} , wherein based on the boost status signal PWM_{boost} , the boost control logic unit **52** generates the boost control signal. The buck controller **206** comprises: a second comparator **61** having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal V_{IN} , the second input terminal is configured to receive a second threshold V_{ref2} , and wherein based on the feed forward signal and the first threshold V_{ref1} , the second comparator **61** generates the buck status signal PWM_{buck} at the output terminal; and a buck control logic unit **62** coupled to the output terminal of the second comparator **61** to receive the buck status signal PWM_{buck} , wherein based on the buck status signal PWM_{buck} , the buck control logic unit **62** generates the buck control signal.

In one embodiment, the first threshold V_{ref1} is higher than the second threshold V_{ref2} , wherein the first threshold is related to the boost threshold, and the second threshold is related to the buck threshold.

In one embodiment, the switching mode power supply **200** further comprises a feed forward circuit **208** coupled to the input port to receive the input signal, and to generate the feed forward signal based thereupon. In one embodiment, the feed forward circuit **208** comprises a first resistor and a second resistor coupled in series between the input port and the reference ground, wherein the feed forward signal is provided at the conjunction of the first resistor and the second resistor.

FIG. 3 schematically shows a switching mode power supply **300** with a buck controller **306** in accordance with an embodiment of the present disclosure. In the example of FIG. 3, the buck controller **306** comprises: a second comparator **61** having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal V_{IN} , the second input terminal is configured to receive the second threshold V_{ref2} , and wherein based on the feed forward signal and the second threshold V_{ref2} , the second comparator **61** generates the buck status signal PWM_{buck} at the output terminal; a hysteretic comparator **63** having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal V_{IN} , the second input terminal is configured to receive a reference voltage V_R , and wherein based on the feed forward signal, the reference voltage V_R , and an inherent hysteresis of the hysteretic comparator **63**, the hysteretic comparator **63** generates a switching signal at the output terminal; and a logic circuit **64** having a first input terminal, a second input terminal, and an output terminal, wherein the first input terminal is coupled to the output terminal of the second comparator **61** to receive the buck status signal PWM_{buck} , the second input terminal is coupled to the output terminal of the hysteretic comparator **63** to receive the switching signal, and wherein based on the buck status signal PWM_{buck} and the switching signal, the logic circuit **64** generates the buck control signal at the output terminal.

In one embodiment, the logic circuit **64** comprises an AND gate.

When the input signal V_{IN} is higher the UVLO threshold, the switching mode power supply **300** is in operation. If the feed forward signal is higher than the first threshold V_{ref1} , which indicates that the input signal is higher than the boost threshold, the buck controller **306** is blocked, and the boost

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controller **305** is activated, so that the power stage operates in boost mode as discussed hereinbefore. But if the feed forward signal becomes lower than the second threshold V_{ref2} , which indicates that the input signal becomes lower than the buck threshold, and the storage voltage V_s is higher than the input signal V_{IN} , the boost controller **305** is blocked, and the buck controller **306** is activated, so the power stage **310** operates in buck mode. Specifically speaking, when the power stage **310** operates in buck mode, in one hand, the second comparator **61** provides a logical high buck status signal PWM_{buck} to the AND gate. In the other hand, the feed forward signal is compared with an upper limit and a lower limit of the hysteretic comparator **63**, wherein the upper limit and the lower limit are formed by the reference voltage V_R and the inherent hysteresis of the hysteretic comparator **63**. If the feed forward signal is lower than the lower limit, the switching signal generated by the hysteretic comparator **63** is logical high. So the buck control signal PWM_{buck} generated by the logic unit **64** is logical high. Accordingly, the upper switch **301** is turned on, and the lower switch **302** is turned off, to extend the on time of the upper switch **301** and shorten the on time of the lower switch **302**. As a result, the input signal V_{IN} increases. If the input signal V_{IN} increases to be higher than the upper limit, the switching signal generated by the hysteretic comparator **63** is logical low. So the buck control signal PWM_{buck} generated by the logic unit **64** is logical low. Accordingly, the upper switch **301** is turned off, and the lower switch **302** is turned on, to extend the on time of the lower switch **302** and shorten the on time of the upper switch **301**. As a result, the input signal V_{IN} decreases. If the input signal V_{IN} decreases to be lower than the lower limit, the buck controller **306** again turns on the upper switch **301** and turns off the lower switch **302**, and the operation of the switching mode power supply **300** repeats. By such regulation, the hysteretic comparator **63** ensures the input signal V_{IN} to follow the reference voltage V_R during buck mode.

FIG. 4 schematically shows a switching mode power supply **400** with a buck controller **406** in accordance with an embodiment of the present disclosure. In the example of FIG. 4, the buck controller **406** comprises: a second comparator **61** having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal V_{IN} , the second input terminal is configured to receive the second threshold V_{ref2} , and wherein based on the feed forward signal and the second threshold V_{ref2} , the second comparator **61** generates the buck status signal PWM_{buck} at the output terminal; a constant on time unit **65** configured to receive the feed forward signal indicative of the input signal, wherein based on the feed forward signal, the constant on time unit **65** generates a switching control signal; and a logic circuit **64** having a first input terminal, a second input terminal, and an output terminal, wherein the first input terminal is coupled to the output terminal of the second comparator **61** to receive the buck status signal PWM_{buck} , the second input terminal is coupled to the constant on time unit **65** to receive the switching signal, and wherein based on the buck status signal PWM_{buck} and the switching signal, the logic circuit **64** generates the buck control signal at the output terminal.

In one embodiment, the logic circuit **54** comprises an AND gate.

When the input signal V_{IN} is higher than the UVLO threshold, the switching mode power supply **400** is in operation. When the switching mode power supply **400** operates in buck mode, the switching signal provided by the constant on time

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unit **65** has a constant on time and a variable off time in each switching cycle time, so as to regulate the input signal at desired voltage level.

Several embodiments of the foregoing switching mode power supply provide energy management by bi-directional buck boost conversion with only one power stage (e.g. composed by two switches coupled in series) compared to conventional technique discussed above. Unlike the conventional technique, several embodiments of the foregoing switching mode power supply provide any desired storage voltage by regulating the power stage without adopting more switches. Furthermore, several embodiments of the foregoing switching mode power supply control the switches in the power stage to operate at switching state, which reduces power loss and increases the system efficiency.

FIG. 5 schematic shows a flowchart **500** of a method for a switching mode power supply in accordance with an embodiment of the present disclosure. The method comprises: step **501**, comparing an input signal with a UVLO threshold: if the input signal is higher than the UVLO threshold, go to step **502**; and if not, continue comparing the input signal with the UVLO threshold; step **502**, start; step **503**, monitoring the input signal; step **504**, comparing the input signal with a boost threshold: if the input signal is higher than the boost threshold, go to step **505**; and if not, go to step **506**; step **505**, entering boost mode to pump the input signal into a higher level to get a storage voltage; step **506**, comparing the input signal with a buck threshold and the storage voltage: if the input signal is both lower than the buck threshold and the storage voltage, go to step **507**; and if not, back to step **503**; step **507**, entering buck mode to release the storage voltage; step **508**, comparing the input signal again with the UVLO threshold, if the input signal is lower than UVLO threshold, go to step **509**; if not, back to step **506**; and step **509**, end; wherein the buck threshold is lower than the boost threshold.

In one embodiment, the method further comprises adopting hysteretic control in buck mode.

In one embodiment, the method further comprises adopting constant on time control in buck mode.

In one embodiment, the method further comprises maintaining the switching mode power supply in the previous mode, if the input signal is higher than the buck threshold and is lower than the boost threshold.

While specific embodiments of the present disclosure have been provided, it is to be understood that these embodiments are for illustration purposes and not limiting. Many additional embodiments will be apparent to persons of ordinary skill in the art reading this disclosure.

We claim:

1. A switching mode power supply, comprising:
 - an input port configured to receive an input signal;
 - a storage port configured to provide a storage voltage;
 - an inductor having a first terminal and a second terminal, wherein the first terminal is coupled to the input port to receive the input signal;
 - a power stage coupled between the second terminal of the inductor and the storage port;
 - a storage capacitor coupled between the storage port and ground to store energy;
 - a boost controller configured to receive a feed forward signal indicative of the input signal, and to generate a boost control signal to control the power stage to operate in boost mode when the input signal is higher than a boost threshold; and
 - a buck controller configured to receive the feed forward signal indicative of the input signal, and to generate a buck control signal to control the power stage to operate

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in buck mode, when the input signal is lower than a buck threshold and when the storage voltage is higher than the input signal; wherein

the buck threshold is lower than the boost threshold.

2. The switching mode power supply of claim 1, further comprising a feed forward circuit coupled to the input port to receive the input signal, and to generate the feed forward signal based thereupon.

3. The switching mode power supply of claim 1, further comprising an input capacitor coupled between the input port and a reference ground to smooth the input signal.

4. The switching mode power supply of claim 1, further comprising an under voltage lock out block configured to compare the input signal with the input signal; wherein

if the input signal is higher than an under voltage lock out threshold, the switching mode power starts to operate; and

if the input signal is lower than the under voltage lock out threshold, the operation of the switching mode power supply ends.

5. The switching mode power supply of claim 1, wherein the power stage comprises an upper switch and a lower switch coupled in series between the storage port and ground, and wherein the conjunction of the upper switch and the lower switch is coupled to the second terminal of the inductor.

6. The switching mode power supply of claim 1, wherein boost controller comprises:

a first comparator having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal, the second input terminal is configured to receive a first threshold, and wherein based on the feed forward signal and the first threshold, the first comparator generates the boost status signal at the output terminal; and

a boost control logic unit coupled to the output terminal of the first comparator to receive the boost status signal, wherein based on the boost status signal, the boost control logic unit generates the boost control signal.

7. The switching mode power supply of claim 6, wherein the first threshold is related to the boost threshold.

8. The switching mode power supply of claim 1, wherein the buck controller comprises:

a comparator having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal, the second input terminal is configured to receive a threshold, and wherein based on the feed forward signal and the threshold, the comparator generates the buck status signal at the output terminal; and

a buck control logic unit coupled to the output terminal of the comparator to receive the buck status signal, wherein based on the buck status signal, the buck control logic unit generates the buck control signal.

9. The switching mode power supply of claim 8, wherein the threshold is related to the buck threshold.

10. The switching mode power supply of claim 1, wherein the buck controller comprises:

a comparator having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal, the second input terminal is configured to receive a threshold, and wherein based on the feed forward signal and the threshold, the com-

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parator generates the buck status signal at the output terminal; and wherein the threshold is related to the buck threshold;

a hysteretic comparator having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal, the second input terminal is configured to receive a reference voltage, and wherein based on the feed forward signal, the reference voltage and an inherent hysteresis of the hysteretic comparator, the hysteretic comparator generates a switching signal at the output terminal; and

a logic circuit having a first input terminal, a second input terminal, and an output terminal, wherein the first input terminal is coupled to the output terminal of the comparator to receive the buck status signal, the second input terminal is coupled to the output terminal of the hysteretic comparator to receive the switching signal, and wherein based on the buck status signal and the switching signal, the logic circuit generates the buck control signal at the output terminal.

11. The switching mode power supply of claim 10, wherein the logic circuit comprises an AND gate.

12. The switching mode power supply of claim 1, wherein the buck controller comprises:

a comparator having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal, the second input terminal is configured to receive a threshold, and wherein based on the feed forward signal and the threshold, the comparator generates the buck status signal at the output terminal; and wherein the threshold is related to the buck threshold;

a constant on time unit configured to receive the feed forward signal indicative of the input signal, wherein based on the feed forward signal, the constant on time unit generates a switching control signal; and

a logic circuit having a first input terminal, a second input terminal, and an output terminal, wherein the first input terminal is coupled to the output terminal of the comparator to receive the buck status signal, the second input terminal is coupled to the constant on time unit to receive the switching signal, and wherein based on the buck status signal and the switching signal, the logic circuit generates the buck control signal at the output terminal.

13. A method used for a switching mode power supply, comprising:

comparing an input signal with an under voltage lock out threshold:

start to operate the switching mode power supply until the input signal is higher than the under voltage lock out threshold;

comparing the input signal with a boost threshold: if the input signal is higher than the boost threshold, controlling the switching mode power supply enter boost mode to pump the input signal into a higher level to get a storage voltage; and if not, go to next step;

comparing the input signal with a buck threshold and the storage voltage: if the input signal is lower than both the buck threshold and the storage voltage, controlling the switching mode power supply enter buck mode to release the stored voltage; and if not, go to next step; and

comparing the input signal again with the under voltage lock out threshold: if the input signal is lower than the under voltage lock out threshold, stopping the operation of the switching mode power supply; and if not, back to

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the step of comparing the input signal with the buck threshold and the storage voltage.

14. The method of claim 13, further comprising adopting hysteretic control when the switching mode power supply enters buck mode.

15. The method of claim 13, further comprising adopting constant on time control when the switching mode power supply enters buck mode.

16. The method of claim 13, further comprising maintaining the switching mode power supply in the previous mode, if the input signal is higher than the buck threshold and is lower than the boost threshold.

17. A switching mode power supply, comprising:

an input port configured to receive an input signal;

a storage port configured to provide a storage voltage;

an inductor having a first terminal and a second terminal, wherein the first terminal is coupled to the input port to receive the input signal;

an upper switch having a first terminal and a second terminal, wherein the first terminal is coupled to the second terminal of the inductor, the second terminal is coupled to the storage port;

a lower switch having a first terminal and a second terminal, wherein the first terminal is coupled to the second terminal of the inductor, the second terminal is coupled to a reference ground;

a storage capacitor coupled between the storage port and ground to store energy;

a boost controller configured to receive a feed forward signal indicative of the input signal, and to generate a boost control signal to control the upper switch and the lower switch to cause the switching mode power supply operate in boost mode when the input signal is higher than a boost threshold; and

a buck controller configured to receive the feed forward signal indicative of the input signal, and to generate a buck control signal to control the upper switch and the lower switch to cause the switching mode power supply operate in buck mode, when the input signal is lower than a buck threshold and when the storage voltage is higher than the input signal; wherein

the buck threshold is lower than the boost threshold.

18. The switching mode power supply of claim 17, wherein the boost controller comprises:

a first comparator having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal, the second input terminal is configured to receive a first threshold, and wherein based on the feed forward signal and the first threshold, the first comparator generates the boost status signal at the output terminal; and

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a boost control logic unit coupled to the output terminal of the first comparator to receive the boost status signal, wherein based on the boost status signal, the boost control logic unit generates the boost control signal; wherein the first threshold is related to the boost threshold.

19. The switching mode power supply of claim 17, wherein the buck controller comprises:

a comparator having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal, the second input terminal is configured to receive a threshold, and wherein based on the feed forward signal and the threshold, the comparator generates the buck status signal at the output terminal; and

a buck control logic unit coupled to the output terminal of the comparator to receive the buck status signal, wherein based on the buck status signal, the buck control logic unit generates the buck control signal; wherein the threshold is related to the buck threshold; wherein the threshold is related to the buck threshold.

20. The switching mode power supply of claim 17, wherein the buck controller comprises:

a comparator having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal, the second input terminal is configured to receive a threshold, and wherein based on the feed forward signal and the threshold, the comparator generates the buck status signal at the output terminal; and wherein the threshold is related to the buck threshold;

a hysteretic comparator having a first input terminal, a second input terminal and an output terminal, wherein the first input terminal is configured to receive the feed forward signal indicative of the input signal, the second input terminal is configured to receive a reference voltage, and wherein based on the feed forward signal, the reference voltage and an inherent hysteresis of the hysteretic comparator, the hysteretic comparator generates a switching signal at the output terminal; and

a logic circuit having a first input terminal, a second input terminal, and an output terminal, wherein the first input terminal is coupled to the output terminal of the comparator to receive the buck status signal, the second input terminal is coupled to the output terminal of the hysteretic comparator to receive the switching signal, and wherein based on the buck status signal and the switching signal, the logic circuit generates the buck control signal at the output terminal.

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